

XXXVII.—*On a Collection of Birds made in the Sudan by Major S. S. Flower, O.B.E., in December 1920 and January and February 1921; and some remarks on "A List of the Birds of the Anglo-Egyptian Sudan" by W. L. Sclater and C. Mackworth Praed.* By M. J. NICOLL, M.B.O.U.

THE following paper is based on a small collection of birds made by Major S. S. Flower during a visit to the Sudan in December 1920, January and February 1921, and which has been placed in my hands for determination and reporting on.

I have taken the present opportunity to add to this account a few remarks on some Sudan birds other than those contained in the collection under review but mentioned by Messrs. Sclater & Praed in their paper recently published in 'The Ibis.'

In the present collection one new race is represented, i. e. *Galerida cristata halfa*, which I have already described in the Bull. B. O. C. vol. xlii, p. 7. The type of this form and one other example are now in the Tring Museum, the remainder of the collection is in the Giza Zoological Museum.

The specimens of *Pycnonotus barbatus arsinov* from Halfa and the examples of *Hoplopterus spinosus* from different localities in the Sudan are worthy of further examination when a larger series is available.

***Cenanthe isabellina* (Gretzschmar).**

1 ♂. Um Ruaba, Kordofan; ♂. Singa, Blue Nile; ○. Kabashia, Berber; 2 ♀. Halfa. Dec. 1920, Jan. Feb. 1921.

It is interesting to note that all these examples are of the brown phase, or race, and unlike all the other specimens in the Giza Museum from the Sudan, which are very grey on the upper parts.

***Cenanthe cenanthe cenanthe*.**

♂ ♀. Um Ruaba, Kordofan, Dec. 1920. ♂. Singa, Jan. 1921.

***Enanthe hispanica melanoleuca* (Güldenstädt).**

♂. Senmar, Dec. 1920. ♀. Um Ruaba, Kordofan, Dec. 1920.

***Enanthe deserti deserti* (Temminck).**

5 ♂, 3 ♀. Kabashia, Berber, Jan. 1921. 2 ♂. Halfa, Feb. 1921.

The two forms of Desert Chat which occur in northern Africa are *E. d. deserti*, the eastern form, and *E. d. homochroa*, the western form. Both occur as residents in Egypt, though there appears to be a slight migration of the western form in spring.

In my 'Handlist,' page 3, I wrongly used the name *atroregularis* for the eastern race.

***Enanthe lugens persica* (Seebohm).**

♀. Halfa, Feb. 1921.

The winter range of this Chat extends to Egypt and the Sudan. I have an adult female which I shot at Abu Hamed in winter, and we also have two winter specimens from Upper Egypt.

The western race of *lugens* has occurred in Egypt; an adult female, shot by myself in Giza Province on 24.ii.1909, is in our Museum.

The actual meeting place of *O. l. lugens* and *O. l. halophila* is not known, but I obtained a pair of adult birds near the Giza Pyramids, getting into breeding condition, on 28 February, 1921. The male is a typical *halophila*, and the female *lugens lugens*!

***Galerida cristata halfæ* Nicoll.**

*Galerida cristata halfæ* Nicoll, Bull. B. O. C. vol. xlii, 1921, p. 7.

3 ♂, 4 ♀. Halfa, Feb. 1921.

This interesting race, occurring between the ranges of *G. c. altirostris* and *nubica*, was hardly a surprise to me as I had seen, though not obtained, examples in 1910.

As I have stated before, I cannot agree with my friend Hartert on his later nomenclature of these Larks. The name

*altirostris*, given by Brehm in 'Vogelfang' 1855, must be used for the Egyptian, and not for the Dongola bird. The error has been repeated by Selater & Praed in their paper (Ibis, 1918, p. 607). They also are in error in assuming that the Egyptian "*altirostris*" is the same as the Dongola bird, which is wrongly called *altirostris* by Hartert. The two forms are most distinct. The authors, while adopting Hartert's views, use the older name of Brehm's for the Upper Egyptian forms (1855), and include the Dongola bird under this form! Thus making "confusion worse confounded."

***Calandrella brachydactyla brachydactyla* (Leisler).**

♀. Kabashia, Berber, Jan. 1921.

***Calandrella brachydactyla hermonensis* Tristram.**

*Calandrella brachydactyla rubiginosa* Nicoll, 'Handlist,' p. 38.

1 ♀, 2 ♂. Kabashia, Berber, Dec. 1920.

This appears to be the first record of this well-marked race from the Sudan. I have other winter specimens in our Museum from Khartoum. This race, which has been found breeding in Egypt, is easily separable from the typical form by its paler, more sandy, coloration, and by the rufous coloration of the crown of the head.

***Calandrella brachydactyla longipennis* (Eversmann).**

1 ♂, 1 ♂. Kabashia, Berber, Jan. 1921 and Dec. 1920.

These are quite typical *longipennis*, and the occurrence of this race in the Sudan is now recorded for the first time.

***Passer domesticus niloticus* Nicoll & Bonhote.**

*Passer domesticus halje* Meinertzhagen, Bull. B. O. C. xli. 1921, p. 67.

17 ♂, 5 ♀. Halfa, Feb. 1921.

I regret that I am unable to agree with Meinertzhagen. The series collected by Flower are not separable from birds from other parts of Egypt. Meinertzhagen gives, as a distinguishing character, a larger amount of chestnut on the

upper parts. This is not borne out in our series, and it must be remembered that in Upper Egypt, where it is warmer, male Sparrows assume summer plumage earlier than they do in Lower Egypt. I do not know in what month the material seen by Meinertzhagen was collected. I suspect that his birds were more advanced than those collected by Flower. In full breeding plumage, a male Sparrow from Lower Egypt is most remarkably different from a bird in winter plumage.

The races *P. d. alexandrinus* Madarasz, and *P. d. chephronis* Phillips, are indistinguishable from *niloticus*.

*Passer d. niloticus* breeds from the coast of the Mediterranean to, at least, as far south as Halfa. At Abu Hamed, Berber Province, and Merowe, in Dongola, there occur Sparrows which, except for their slightly shorter wings, are identical with *niloticus*. At the same places, however, *P. d. arboreus* occurs, and the examples under discussion are probably hybrids.

***Passer hispaniolensis hispaniolensis* (Temminck).**

♂. Halfa, Feb. 1921.

In January 1911 I shot a Spanish Sparrow at Merowe, Dongola Province, and this, the first example recorded from the Sudan, I assign to the typical race. I have lately, through the courtesy of the Government Entomologist of the Wellcome Research Laboratories at Khartoum, been enabled to examine a series of *Passer hispaniolensis* collected recently in Dongola Province, and these I find to be all of the eastern race *P. h. transcaspicus*.

Since my 'Handlist' was published I have identified Egyptian winter-shot examples of this eastern race.

***Emberiza cæsia* Cretzschmar.**

♂. Sennar, Jan. 1921.

***Serinus leucopygius* (Sundevall).**

1 ♂, 2 ♀. Um Ruaba, Kordofan, Dec. 1920.

***Spiloptila clamans* (Temminck).**

2 ♀. Um Ruaba, Kordofan, Dec. 1920.

*Lagonosticta senegala* subsp. ?

♀. Halfa, Feb. 1921.

This bird was trapped by a native boy, and was probably an escape.

*Sitagra luteola* (Lichtenstein).

1 ♂. Um Ruaba, Kordofan, Dec. 1920. 1 ♂, 1 ♀. Singa, Jan. 1921. 1 ♀. Sennar, Jan. 1921.

*Pyrrhulanda leucotis melanocephala* (Lichtenstein).

♂. Um Ruaba, Kordofan, Dec. 1920.

This specimen has practically entirely black lesser wing-coverts.

*Riparia paludicola minor* (Cabanis).

♂. Singa, Jan. 1921.

*Munia cantans* (Gmel.).

One male, from Um Ruaba, Dec. 1920, probably belongs to Mearns's race *Aidemosyne inornata*, as probably does one example from the same locality now living in the Giza Zoological Gardens.

*Passer luteus* (Lichtenstein).

♂. Um Ruaba, Kordofan, Dec. 1920.

*Lanius excubitor pallidirostris* Cassin.

1 ♀. Um Ruaba, Kordofan, Dec. 1920.

*Lanius excubitor leucopygos* HEMP. & EHRENB.

1 ♀. Kabashia, Berber, Dec. 1920.

*Phylloscopus collybita collybita* (Vieillot).

2 ♂. Halfa, Feb. 1921.

*Spreo pulcher* (Müller).

1 ♀. Kabashia, Berber, Dec. 1920.

*Anthus cervinus* (Pallas).

♂. Sennar, Jan. 1921.

**Motacilla feldegg melanogriseus** (Homeyer).

♂. Um Ruaba, Kordofan, Dec. 1920.

I prefer to separate the Black-headed Wagtails from the Blue-headed form.

There are several "Yellow Wagtails" in this collection, but as they are young and female birds, it is not possible to identify them.

**Motacilla feldegg feldegg** Michahelles.

♂. Singa, Jan. 1921.

**Motacilla flava flava** Linnæus.

1 ♂. Um Ruaba, Kordofan, Dec. 1920. 3 ♂. Singa, Jan. 1921.

**Corvus ruficollis ruficollis** Lesson.

2 ♂, 1 ♀. Halfa, Feb. 1921.

These are typical large-billed examples and well match specimens from other parts of Egypt. The Brown-necked Raven is, in my opinion, a different species and not a race of *C. corax*. There are, moreover, two distinct forms, *C. r. ruficollis* and *C. r. infumatus*. The latter apparently occurs at or near Suez, in Egypt, and in parts of the Sudan. I have not yet seen a typical *ruficollis* from south of Halfa.

**Corvus albus** Müller.

♂. Um Ruaba, Kordofan, Dec. 1920. ♂. Sennar, Jan. 1921.

**Trachyphonus margaritatus margaritatus** (Cretzschmar).

♂ ♀. Kabashia, Berber. Dec. 1920.

**Campethera nubica** (Gmelin).

♂. Um Ruaba, Kordofan, Dec. 1920.

**Ceryle rudis rudis** (Linnæus).

♂. Singa, Jan. 1920.

**Merops orientalis viridissimus** Swainson.

Two sexed ♀ ♀, probably ♂ ♂. Kabashia, Berber, Jan. 1921.

I do not understand Selater and Praed when they say that

the wing measurements of specimens of *M. o. cleopatra*, in the British Museum, average 63 mm. Those in the Giza Museum average 92 mm. ; over 20 measured.

The name *lamark* used by S. & P. is antedated by *orientalis*.

***Pycnonotus barbatus arsinœ* (Lichtenstein).**

A pair from Halfa, Feb. 1921, are decidedly different in coloration from any of our series at Giza. It would be interesting to compare a large series from the vicinity of Halfa.

***Bubo africanus cinerascens* Guerin.**

♀. Singa, Jan. 1921.

***Tyto alba alba* (Scopoli).**

♀. Sennar, Jan. 1921.

The Barn-Owl varies considerably throughout its range in Egypt and the Sudan. I have seen specimens in Egypt as dark as, or even darker than, the so-called *maculata*, of the Sudan. On the other hand, some specimens from Khartoum, which I have seen, are as pale and little spotted as are the majority of Egyptian examples.

***Otus scops scops* (Linnæus).**

♀. Sennar, Jan. 1920.

***Falco biarmicus abyssinicus* Neumann.**

A young ♀. Singa, Jan. 1921.

***Falco tinnunculus tinnunculus* Linnæus.**

♂. Um Ruaba, Kordofan, Dec. 1920. 2 ♀. Halfa, Feb. 1921.

These agree well with the pale Kestrels which pass through Egypt, and must at present be assigned to this form though they seem to be a little paler than British examples.

***Milvus migrans parasitus* (Daudin).**

1 ♂, 1 ♀. Sennar and Singa respectively, Jan. 1921.

***Milvus migrans ægyptius* (Gmelin).**

♂. Halfa, Feb. 1921.

This was probably breeding or about to do so, as a note on the label says "Testes enlarged."

***Streptopelia senegalensis sudanensis* Selater & Praed.**

A pair from Halfa, Feb. 1921.

Senegal Doves from Halfa, Berber, and Dongola are distinctly paler than birds from Rejaf. Examples from the Blue Nile are intermediate. With the small amount of material at my disposal I have provisionally followed Selater and Praed in calling the Halfa birds *sudanensis*.

***Streptopelia turtur isabellina* (Bonaparte).**

A male and five living examples from Halfa, Feb. 1921.

I have one other Sudan specimen from Blue Nile Province obtained 1. xi. 10, where it is not uncommon in winter.

One of the living birds is a young bird in first plumage.

I cannot separate Sudanese specimens from Egyptian breeding birds.

***Streptopelia decipiens decipiens* Finsch & Hartl.**

1 ♂. Kabashia, Berber, Dec. 1920.

This example is paler on the back than examples in the Giza Museum from the Blue and White Niles.

***Ena capensis* (Linnæus).**

♂. Um Ruaba, Kordofan, Dec. 1920.

This single example is strikingly greyer on the upper parts than are four males in the Giza Museum from Khartoum and the White Nile.

***Coturnix coturnix coturnix* (Linnæus).**

♂. Halfa, Feb. 1921.

***Pterocles senegallus* (Linnæus).**

♂. Khartoum, Jan. 1921.

***Pterocles senegalensis senegalensis* (Lichtenstein).**

*Pterocles exustus* auctorum.

2 ♂, 3 ♀. Kabashia, Berber, Dec. 1920. 1 ♀. Khartoum, Jan. 1921.

***Sarkidiornis melanotus africanus* Eyton.**

2 ♂. Singa, Jan. 1921.



***Dendrocygna fulva*** (Gmelin).

♂ juv. Um Ruaba, Kordofan, Dec. 1920.

***Fuligula fuligula*** (Linnæus).

♂ ♀. Singa, Jan. 1921.

The male has the underparts and parts of the tail stained a deep rusty chestnut. I have never seen a duck stained to such an extent. The new feathers which are appearing in the tail and on the abdomen are normally coloured.

***Fuligula brunnea*** (Eyton).

A live bird from Um Ruaba, Kordofan, obtained Dec. 1920.

This example, Flower tells me, was quite a young bird; he saw it in the yard of an Arab's house with young specimens of *Dendrocygna*. The owner, who did not distinguish this bird as different from his other young ducks, stated that he had obtained them all from the Um Ruaba "fulah," where many waterfowl breed.

This seems to be a very great northern extension of the range of this duck.

I use Eyton's name for this species as, owing to lack of literature, I do not know if Neuwied's name *erythrophthalma* is applicable as stated by Sharpe, 'Hand-list of Birds,' vol. i. p. 223.

***Himantopus himantopus*** (Linnæus).

♂ ♀. Um Ruaba, Kordofan, Dec. 1920.

***Charadrius alexandrinus alexandrinus*** (Linnæus).

♀. Sennar, Jan. 1921.

This example has a wing of 111 mm., and is undoubtedly of the typical form. Specimens from Egypt vary in wing measurement: out of a large series, eight in the Giza Museum are from 100 to 104 mm., but one of these was breeding with long-winged birds.

***Charadrius dubius curonicus*** Gmelin.

2 ♂, 1 ♀. Singa; 2 ♂. Sennar. Jan. 1921.

Two of these are getting the black collar and frontal band of summer plumage. It seems to be little understood that

in winter, in Egypt at any rate, adults of this species, *C. hiaticula tundræ*, and *C. alexandrinus* have the collar and frontal band replaced by brown.

True adults of the last-named assume, after the autumn moult, a bright chestnut crown to the head.

***Erolia minuta minuta* (Leisler).**

♂. Um Ruaba, Kordofan, Dec. 1920. ♂. Sennar, Jan. 1921.

***Chettusia leucura* (Lichtenstein).**

♀. Um Ruaba, Kordofan, Dec. 1920.

***Pluvianus ægyptius* (Linnæus).**

1 ♂. Sennar, Jan. 1921. 2 ♀. Singa, Jan. 1921.

***Sarciophorus tectus* Boddaert.**

♂. Um Ruaba, Kordofan, Dec. 1920.

***Hoplopterus spinosus* (Linnæus).**

4 ♂, 3 ♀. Kordofan, Berber, and Blue Nile, Dec. 1920 and Jan. 1921.

Sudan examples are darker on the upper parts, and have consistently shorter wings than our Egyptian examples in the Giza Museum.

***Ædicnemus senegalensis* Swainson.**

1 ♂, 2 ♀. Singa, Jan. 1921.

Birds from the Blue and White Niles in our collection at Giza are slightly smaller in the wing than Egyptian birds. I could not, however, separate the latter on comparing them with a large series at Tring.

***Machetes pugnax* (Linnæus).**

2 ♂. Singa, Jan. 1921.

***Tringa hypoleuca* Linnæus.**

Seven. Singa and Sennar, Jan. 1921.

***Tringa glareola* Linnæus.**

♀. Sennar, Jan. 1921.

***Tringa ocropus* Linnæus.**

♀. Sennar, Jan. 1921.

***Tringa stagnatilis* (Bechstein).**

♂. Singa, Jan. 1921.

***Tringa nebularia* (Gunner).**

♀. Sennar, Jan. 1921.

***Porzana parva* (Scopoli).**

One, probably a female. Singa, Jan. 1921.

***Phalacrocorax africanus* (Gmelin).**

2 ♀. Singa and Sennar, 1921.

***Colymbus ruficollis capensis* (Salvadori).**

A young male in first plumage. Um Ruaba, Kordofan, Dec. 1920.

***Sylvia rüppelli* Temminck.**

Sclater and Praed, page 661, are I think in error in supposing the females they describe to be young birds. A large series which we have from Egypt shows that the female of this Warbler never has a black crown. Some, which I take to be really adult, not to say old birds, have a dark grey throat. The usual female plumage much resembles that of a Lesser Whitethroat but is a little darker. Sometimes a little blackish is apparent on the crown.

***Hypolais pallida pallida* (Hemp. & Ehrenb.).**

The typical form seems to be restricted to Egypt and the Sudan, "Nubia" included. Slater and Praed's statement that it breeds in S.E. Europe and W. Asia is not correct, as the form from those countries is *H. p. elatica*. I have one specimen of the latter from Giza, Egypt, in April, and it is possible that it may be found to visit the Sudan in winter.

***Locustella luscinioides luscinioides* (Savi).**

I do not know on what authority Shelley based his statement that this bird was a resident in Egypt. I have no proof that it is more than a spring and autumn migrant.

**Lanius senator senator** = **Phoneus s. senator** S. & P.

This, the typical form, is not uncommon, on migration, in Egypt, as is also the eastern *L. s. niloticus*.

**Lanius minor** Gmelin.

We have three or more specimens in the Giza Museum from Khartoum, all in immature plumage and obtained in August and September by Flower and the late Capt. Halhed.

I do not think that August is early for this bird to appear in the Sudan, as it passes through Egypt in large numbers in that month.

**Muscicapa atricapilla semitorquata** Homeyer.

**Muscicapa albicollis** Temm.

Selater and Praed seem to have overlooked the characters by which these two species may be differentiated, at a glance. I have set these forth, at length, in my 'Handlist.'

*M. albicollis* never has any white on the inner web of the rectrices. *M. a. semitorquata* has white on the first, second, and often the third pair. *M. albicollis* sometimes has white on the outer web of the first and second pair, sometimes no white in the tail at all.

Both of these species are common visitors, on migration, to Egypt in spring.

**Hirundo daurica rufula** Temminck.

This is a very common migrant through Egypt in spring, and I have obtained it in autumn. Great numbers pass through the Wadi Natrun in April, and there is no reason to suppose that these come from anywhere else but up from the sources of the Nile.

**Cuculus canorus** Linnæus.

Cuckoos pass through Egypt in July, so it is not unreasonable to suppose that that month is not so early for them to appear in the Sudan. May I be permitted to quote from the old adage: "In July they begin to fly." I might remark that the earliest arrivals, here in Egypt in July, are always adults.

**Upupa epops.**

Page 666. The Egyptian race is not *U. e. major* Nicoll, but *U. e. major* Brehm. I only rediscovered this interesting form which, of late years, owing to the protection given to it, has increased enormously.

**Falco concolor** Temminck.

The range of this Falcon is not yet clearly understood. There is no doubt that it breeds in Egypt, and the examples met with elsewhere are on migration. It is certain that it is a Palearctic form as regards its breeding range, if we include Egypt in the Palearctic region. Its occurrence in Madagascar in winter, as has, I believe, been recorded, shows that it migrates south, so that it is probable that it may be found in the Sudan. At any rate it seems to be a very rare bird, and the appearance of a pair flying round the Giza Zoological Gardens throughout June every year is well worth seeing. I have also seen this pair accompanied by their young.

**Circaëtus gallicus** (Gmelin).

I must disagree with Selater and Praed in their statement regarding the breeding range of this Eagle. As I have stated in my 'Handlist' the Short-toed Eagle is a resident in Egypt.

**Turdus torquatus alpestris** (Brehm).

Unfortunately, Flower only saw and did not obtain the Ring-Ouzel at Dongola, p. 678. It is interesting to hear that this form has occurred in the Sudan, as the only example I have seen from Egypt was *T. t. orientalis*. This I shot at Giza in 1906.

**Monticola solitarius solitarius** (Linnæus).

It is most remarkable that all the specimens from the Sudan should be of this form, for a large series from Egypt in our Museum are all referable to the well-marked race *M. s. transcaspicus* Hartert.

**Gallinula angulata** Sundevall.

The specimen mentioned, page 825, is in our Museum at Giza.

**Columba livia schimperi** Bonaparte.

I consider that it is quite impossible to assign any name to the Pigeon of the Nile Valley between Cairo and Aswan. Pigeons have been kept in a semi-domesticated state for so long in Egypt that it is now almost impossible to shoot two similar birds from the same flock. Although many apparently pure coloured "*schimperi*" may be obtained, I have several similar examples but with pure white "buffer" bands on the back. One may also get feather-footed birds, white, black, pied and red, and chequers, from the same flock. These facts surely speak for themselves.

**Coturnix coturnix coturnix** (Linnæus).

In my 'Handlist' I wrongly, as I now consider, included *C. c. capensis* among the birds of Egypt on the strength of red-throated specimens. Last year (1920) I purchased a great many living Quail, all the males of which were carefully examined, and all were found to be quite typical *C. c. coturnix* as regards the coloration of the throat. I now find (July 1921) that many of these males have assumed deep brick-red throats. It, therefore, seems probable that the Quail, in this country, assumes a red throat in summer.

**Ammoperdix heyi cholmleyi** O.-Grant.

I have examined the specimen obtained by Mr. F. S. Worthington at Aswan (p. 847), and entirely agree with the authors as to its being *cholmleyi*. (Since I published my 'Handlist' I have received a fine pair of adult *A. h. nicolli*, shot by T. W. Russell Pasha, two days' march south of Assuit. This is the farthest south I have yet received evidence of its occurrence.) In the next edition of my list I shall therefore include *A. h. cholmleyi*. We have yet to learn where the two forms meet.

XXXVIII.—*Notes on the Mound-building Birds of Australia, with Particulars of Features peculiar to the Mallee-Fowl, Leipoa ocellata Gould, and a Suggestion as to their Origin.*  
By EDWIN ASHBY, M.B.O.U.

WE are familiar with the views advanced by several writers that the habit of artificially incubating their eggs, common to the Mound-building Birds of Australia, is a survival from their reptilian ancestors. The following notes suggest an alternative explanation, which the data advanced seem sufficiently to support.

*Megapodius reinwardti* Dumont.

The huge mounds made by the Jungle-Fowl, *Megapodius reinwardti*, are well known. In 1906 Mr. C. E. May, who was working on the Government Bore, then testing the shale for coal, at Port Keats, in the Northern Territory, at my request very kindly took the following measurements and supplied me with the notes hereunder :—

Nesting-mound.	Diameter at base. ft.	Circumference. ft.	Height of Mound. ft. ins.	Diameter at top. ft.
No. I. ....	53	167	8 6	17
No. II. ...	46	147	7 6	12
No. III. ...	33	105	5 9	12
No. IV. ...	42	132	7 6	12

All the nests were flattened at the top and were more or less covered with brush-wood, which Mr. May thought had been placed there by the birds with the probable purpose of retarding evaporation and thereby keeping the surface-soil of the mound from baking hard. He also suggested that the flattening of the top was due to the frequent digging out of the eggs by the aborigines.

The mounds are placed in thick jungle, and usually large Tamarind-trees are growing out of them. The Megapode feeds largely on the fruit of the Tamarind, which probably accounts for the consistency with which these trees occur in the mounds, the seeds being excreted by the birds. The same

mound is used season after season, the birds scratching out tunnels from two to five feet deep, penetrating the mounds at an angle of 45 degrees. The eggs of one laying bird are five or six in number, each being placed in a separate tunnel, two to three feet from its neighbour.

The tunnel in nest No. II. had been filled in with green leaves, and a trail sixty feet long led up to the place where the newly laid eggs had been placed.

When nest No. I. was opened, the young man who had worked his way, several feet head-first, into the filled-in tunnel began to make frantic efforts to get out quickly, calling in muffled tones for help. His companions hauled him out by his heels, when out flew a fully fledged chick, which was secured and the skin sent down to the writer. This skin is now, I believe, in the British Museum. It seems that the newly hatched chick was commencing to work itself out, and finding the intruding hand, pecked it vigorously. The young man thought he had been bitten by a snake and naturally was a good deal frightened.

In the case of the *Megapodius* mounds, the fermentation of the leaves and debris filled into the tunnel-like openings produces sufficient heat under the moist tropical conditions to fully incubate the eggs. As the young have to fend for themselves directly they are hatched, Nature provides that they shall be able to run and fly immediately on leaving the egg.

#### **Alectura lathami** Lath. Scrub- or Brush-Turkey.

I have met with this bird in the Blackall Range in southern Queensland and in the semi-tropical brush or forest of northern New South Wales. The country in which these birds occur is moist and tropical. In the first-named locality, we in October 1903 located a recently made nesting-mound of the above species. It was placed at the base of a large Moreton Bay Fig-tree. The leafage overhead was very thick, and the debris and dead leaves underneath had been proportionately thick, but for a radius of fifty feet from the mound the ground had been raked bare,



every loose twig and leaf seemed to have been gathered together and formed into a mound of fermenting material equal to several dray-loads. I have watched the male bird doing this work, taking several, shall I say, handfuls of debris and throwing it backwards until by successive efforts it has reached the spot chosen for the mound.

In the moist warm conditions of that forest, fermentation quickly commences and accumulated material rapidly generates heat.

We went through the mound in question and found that it was too fresh for the deposition of eggs; the temperature must have been very high—indeed, so hot that the eggs, if placed in it, would have been almost, if not quite, cooked. One cannot help asking how and by what means do the birds know when the temperature is right for their purpose.

The Scrub-Turkey evidently has some knowledge of the conditions that are necessary for satisfactory incubation, and refrains from placing its eggs in the nesting-mound until this is reached. This suggests a rather high order of intelligence.

#### *Leipoa ocellata* Gould. The Mallee-Fowl.

This fine bird inhabits almost exclusively the vast tracts of the drier parts of Australia which are covered with the various species of the dwarf branching forms of *Eucalypti* known as Mallee.

All opportunities that I have personally had of examining the nesting-mounds of this bird have been in the extensive belt of Mallee lying on both sides of the valley of the River Murray in South Australia.

The birds usually select a sandy rise and commence the nesting-mound by excavating a hole—in the case of the one I examined in this stage, situated about fifteen miles from the town of Mannum, the excavation was about eighteen inches deep and six feet or more across. For some reason the birds had forsaken this spot at this stage and made the nesting-mound on another sandy rise some distance away.

In reference to the digging of the hole for the foundation

of the future mound, Mr. G. H. Mann writes me, 10 March, 1922, that "From my observations it seems that they scratch out a hole early in the winter and then fill it up with a cone-shaped heap of dry leaves and sticks: these they cover with sand about the end of the winter."

These sticks and leaves ultimately become largely intermixed with the sand, but the leaves and twigs are mostly below the eggs. Most of the mounds in the belt of Mallee before referred to, were when finished nine feet to twelve feet across, with a depression in the middle, and raised about two feet above the normal level of the ground. Mr. J. E. Lewis Machell, of the Education Department in Adelaide, furnished me with some very valuable observations in a letter dated 4 March, 1922; I give them in full. "I am forwarding the answers to your queries *re* Mallee-Fowl. These are simply notes and observations made by me during 1914, together with a photograph taken at Murray Bridge in January last. Nest, fifteen feet in diameter and about two feet six inches high, situated in an open space in a scrub of so-called 'broom' with occasional Mallee: soil sandy. Composition of nesting-mound, central portion decaying leaves and vegetation covered with sand. There is a depression in the centre, and eggs are laid around the rim of this hollow. Before making the nest a small hollow is scraped out: the one I mentioned was only about five inches deep and two feet six inches wide, and was filled with leaves and twigs. The eggs did not appear to be laid down as far as the leaves. Many were standing on end, but not all. I may have disturbed them when opening up the nest. The sand was fairly dry where the eggs were, but not as dry as in other parts of the nest. Foxes robbed the nests as fast as the eggs were laid (note fox-tracks on mound in photograph). In 1914 I had the pleasure of watching the birds at work, but it meant lying hidden from 6 o'clock in the morning until 10 o'clock. I could hear the birds moving around, but they did not appear. About 10 A.M. (when the sun was shining directly on the nest), the male and female appeared on the mound. The female stayed, but the male disappeared

into the scrub again to do sentry-go. Well, Mrs. Mallee-Fowl began to open out the egg-chamber; every few minutes she would pause and appeared to settle her neck and breast against the sides of the egg-chamber. The sand was cleared away until there was about an inch left covering the eggs, then the male joined her and both disappeared. On visiting the nest at 4 P.M. (the shadows were just on the nest), I found that the sand had been replaced."

"I repeated this observation the following day and again a week later, and the sand was always replaced before the shadows fell on the nest."

Mr. T. P. Bellechambers of South Australia wrote me on 7 March, 1922, as follows:—"All covering material is mixed with desiccated leaves. For sunning purposes, *i. e.* 'solar heat,' the nest is opened almost to the level of the eggs—this may be done as often as five days out of seven. The refilling is a gradual process and takes all day, as it is replaced in layers as soon as it gets hot. The male does all the hard graft, grasps and throws all the material behind him."

It will be seen that, while on the important point, the utilization of solar heat, all the three observers quoted above are in agreement, Mr. Mann adds "I do know that they (the Mallee-Fowl) open out the nests mostly in the morning, but have the impression that they are not long left open"—the depth of the initial excavation varies somewhat.

In the example that came under my personal observation, the excavation was considerably deeper than was the case with the nest examined by Mr. Machell; we may therefore conclude that this varies with the depth of the sand and the nature of the soil. Again, while Mr. Bellechambers only quotes the male as doing the filling work, Mr. Machell records the work as done by the female. Some differences may be due to the fact that Mr. Bellechambers's birds are in semi-captivity.

I think we may conclude that, while this work may probably be largely undertaken by the male, both sexes share therein. Mr. Machell's observation of the bird pressing

her neck and breast against the egg-chamber is quite unique, and suggests the possibility that this action is part of the method by which the birds ascertain the temperature of the enveloping sand.

My opportunities of personally observing these interesting and shy birds in their native haunts have been too brief and too far apart to furnish conclusive data, but, from my own observations and from the information supplied to me from time to time by dwellers in the back blocks, I have long felt satisfied that it is the regular habit of the Mallee-Fowl to open out the nesting-mounds almost down to the eggs on clear, hot, sunshiny days—this opening being done as soon as the sun is well up. The sand is rather widely distributed and heated by the sun's rays to a high degree. The birds always return fairly early in the afternoon, which accounts for Mr. Mann's observation "that he is under the impression that they are not long left open"—he seldom passes the nesting-mounds on his way home from work till late in the evening,—the object of the birds' return being to restore the heated sand to the nest. The accumulated heated sand retains its high temperature, or a large amount thereof, for some days. It seems evident that the mounds are not opened by the birds (except for actual egg-laying) on cool cloudy or drizzly days, the birds awaiting the return of a clear sky and the heating power of an unimpeded sunshine. In the districts where Mallee grows this is the normal weather.

In my lectures on Australian Bird-life before Agricultural and Horticultural Societies and other Public Bodies in the State of South Australia, I have often during the last few years told the story of the *Leipoa*, and expatiated upon the wonderful adaptation of its methods to changed climatic conditions, suggesting the following hypothesis by way of explanation.

As is well known, the interior of Australia used to be favoured with a much heavier rainfall than is now the case. The discovery of numerous skeletons of the huge extinct *Diprotodon* half-buried in the dry bed of what was once a

lake at Calabona in South Australia and the survival in a shady gorge of the MacDonalld Ranges of a species of Fan Palm and a *Macrozamia*, both representatives and survivals of a long-distant past when luxuriant vegetation grew there, conclusively support this contention.

A botanist of high standing has advanced the opinion that the "Mallee," a group of Eucalypts that branch from the base and no longer grow into a timber-tree, are the survivors of an ancient forest. Therefore the thousands of square miles of Mallee now existing are the remains of an immense aberrant forest, dwarfed and stunted during the ages because of the steady decrease in the rainfall.

It is quite certain that the spare, stiff, cardboard-like leaves of these Eucalypts and the very dry character of the districts in which they grow, absolutely preclude the possibility of the generation of sufficient heat by fermentation to hatch such eggs that may be deposited there. I therefore judge that in the long-distant past the *Leipoa*, in common with its congeners, *Megapodius* and *Alectura*, gathered together the leafage and debris that must then have thickly strewn the ground under the trees of the luxuriant forests of those distant days.

But slowly and surely the climate changed, the atmosphere grew drier and drier, the forest-trees diminished in size, until we have the dwarf forms of Eucalypts which we know to-day as Mallee.

If we accept this statement of probable facts as correct—the evidence is so strong that it is well-nigh impossible to deduce otherwise,—we may fill in an unwritten page of the past history of Australia's Mound-building Birds.

Instead of their method of incubating their eggs being a survival of an old reptilian habit of simply scratching a hole in the sand and leaving the future of their eggs to the influence of solar heat and chance, we have a group of birds who have acquired highly specialised habits in connection with the incubation of their eggs.

It is impossible to tell whether their progenitors had, in common with most birds, been "nest-makers," hatching their eggs by means of body-heat, and then adopted the method of

hatching them by means of heat produced by the fermentation of organic matter, or whether it was a parallel development. This we can be certain of, viz., that the collecting together of dead leaves into heaps in order that fermentation may be induced, then the awaiting of the time when the necessary heat was generated and the ascertaining of the correct time when the ferment was on the wane and it became safe for the deposition of the eggs, shows an intelligence of a very high order.

The case of the *Leipoa* is still more remarkable. That the rainfall has greatly decreased in the interior of Australia has been sufficiently demonstrated. By reasonable deduction we are safe in asserting that the vegetation of this area will in the past have more or less corresponded with that which now obtains in the habitats of the Jungle-Fowl and the Brush-Turkey.

We are certainly justified in concluding that the Mallee-Fowl, in common with the above-named genera, originally depended entirely for the incubation of its eggs on heat generated by fermenting organic matter. With the reduction of the rainfall a great change took place in the vegetation, ultimately fewer and fewer eggs laid by the Mallee-Fowl were successfully hatched, and the birds were confronted with extermination. There could have been only two alternatives, either a reversion to the methods common to other birds, viz., that of incubation by means of body-heat or the discovery of some new means whereby the temperature of the mounds could be raised. This difficulty has been met and overcome by these intelligent birds in the utilization of solar heat. It will be remembered that conjointly with the reduction of the rainfall came an increase in the periods of clear sky and bright sunshine.

I submit that there is sufficient ascertained data to warrant us in piecing together this page in the past history of the *Leipoa*. It certainly forms one of the most intelligent and remarkable cases of the adaptation of habits to changed circumstances that can be found in the whole realm of Nature below that of man.